DOCUMENT RESUME

ED 161 850 SP 013 234

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TITLE The Relationship Between Biorhythms and Human Performance.
PUB DATE [77]
NOTE 18p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Athletes; Athletics; *Biological Influences; Human Body; Motor Reactions; *Performance Factors; Physical Education; *Psychological Patterns
IDENTIFIERS *Biorhythm Theory

ABSTRACT

The purpose of this investigation was to determine if relationship existed between biorhythms and human performance. The subjects were volunteers from varsity athletic teams and physical education general program classes. Data from varsity athletes were collected from official results of varsity participation and from laboratory testing with the general program subjects. The laboratory testings utilized were choice hand reaction time and whole body movement and performance time. Biorhythms were calculated with the aid of a computer and compared to the performance scores of each subject. Each cycle was analyzed for differences between the positive versus negative phase and critical versus noncritical periods. Analysis for interacton was completed between three cycles--intellectual, emotional, and physical. It was concluded that until supportive evidence is presented, the biorhythm theory serves no value to coach, instructor, or behavioral scientist in predicting fluctuations in human performance. (Authors/JD)

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ED161850

THE RELATIONSHIP BETWEEN BIORHYTHMS AND HUMAN PERFORMANCE

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for design and supervision of statistical analysis.

SP013 234

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In recent years, research has demonstrated that many biological rhythms exert influence over human performance. The list of substances identified as exhibiting a rhythm is impressive and constantly growing. In the present investigation, the term biorhythms is used in reference to the theory popularized by Gittelson and Thommen (1976, 1973). According to the theory, each individuals' biorhythms are set into motion at birth and may be graphically depicted as a sine wave of energy discharge and recharge. Three cycles, physical, emotional, and intellectual, exhibit a sine-wave pattern throughout life and influence our behavior. Better performances can be expected when the rhythms are in the positive phase (discharge) than the negative phase (recharge). The critical day switch from discharge to recharge should demonstrate erratic behavior outside of that observed in the other two phases.

The biorhythm theorists have made impressive claims regarding the accuracy and predictive powers of the theory, but the claims have not always been substantiated. Although predictive accuracy of approximately 70% has been claimed (Gittelson 1976, Thommen 1973), conflicting reports were published with completely opposite results (Mason 1970, Wolcott 1977). Scientists have conducted investigations that dealt mainly with accident reports based on insurance records and subjective evaluation. Recently physical educators have begun to examine biorhythms as they pertain to athletics and motor performance.

Neil and Sink (1976) demonstrated a relationship between biorhythms and a battery of motor performance

tasks which spanned a period of 70 days. Johnson (1974) demonstrated a relationship between biorhythms and self-inflicted football injuries, however the relationship existed in only one of the two groups examined. Significance at the .05 level was found between the emotional cycle and swimming performance of college subjects (Martin, 1973). Subjective evaluation of the data further suggested a relation between the combination of physical and emotional cycles as they effect performance.

Non-supportive evidence is perhaps more impressive than the investigations which lend support. In separate large scale investigations (Mason 1970, Wolcott 1975) involving industrial accidents and air craft disasters, absolutely no correlation was found between the biorhythmic phases and frequency of accident occurrence. Similar results are reported by Rogers (1974) when he attempted to determine the predictive validity of the critical day hypothesis utilizing patients in the Wyoming State Hospital. It is also noted that no one has attempted to identify a causal physiological basis for the biorhythm cycles.

The empirical evidence is inconclusive and physiological basis is nonexistent; therefore a need existed to examine the biorhythm theory and its application to athletics and motor behavior.

Procedures

Subjects were volunteers from varsity athletic teams and physical education general program classes at West

Virginia University. The athletic teams selected were the rifle team (N=7), women's gymnastic team (N=9), the men's gymnastic team (N=11), and the men's and women's swimming teams (N=24). In addition, general program students (N=31) participated in laboratory treatments. Excluded from the study were those volunteers who had knowledge of present personal biorhythms. The data from each sport was analyzed separately, as was the data from the general program. No effort was made to analyze between group differences.

The treatments utilized were actual athletic competition or laboratory testings. The varsity athletes followed the normal practice and competitive schedule with official results providing the data. The general program volunteers were administered two treatments of reaction and performance time. The first treatment was a standard choice hand reaction time test (HRT) where the subject responded to a color coded light to press the corresponding colored lever. The second treatment utilized a whole body reaction timer to measure gross reaction (BRT) and performance time (BPT). A visual stimulus indicated direction and the subject moved accordingly by leaping from the origin in the center to the correct out-lying terminal. The laboratory treatments were administered between 1900 and 2100 hours in the Human Behavior Laboratory of West Virginia University.

No equipment was utilized when investigating the varsity athletes since statistics were compiled from official record books. The above mentioned laboratory

procedure utilized a Lafayette Choice Reaction Timer, Model 6302BX (Lafayette Instrument Co.) and a Takei Kiki Kogyo Whole Body Reaction Timer, Model 1264-I (Takei and Co.) Biorhythms were calculated with the aid of a Digital PDP-12 Computer, Digital Equipment Corporation, Maynard, Massachusetts.

Results were compiled for each varsity athlete and compared to the biorhythm cycles after completion of the season. To accomodate as many general program volunteers as administratively possible, two groups were utilized between the dates a) February 9, 1977-March 31 and b) March 31-May 5. Within each group, ten days were selected for each subject at random between the dates indicated. The treatment schedule was established without inspection of the biorhythms by the investigator or subjects, therefore, a double blind situation was created.

Performance scores collected from laboratory sessions and varsity competition were subjected to Least Squares Analysis of Variance for Unequal Sub-Class Numbers (Steal, 1960). When significance was demonstrated within a main effect, Fishers Least Squared Difference (LSD) Test was used to determine which difference between pairs of means was significant. Critical versus non-critical days and positive versus negative phase were the two contrasts calculated for each rhythm. In addition, interactions between rhythms were computed between physical and emotional cycles, physical and intellectual cycles, and intellectual

and emotional cycles. The analysis was performed using the Statistical Analysis System (SAS) developed at North Carolina State University. Performance scores were correlated with the position of each cycle of the individuals biorhythm. These cycles were coded for statistical purposes according to the phase. The critical day period was determined according to Mason.

Results

No statistical differences were found ($p=.05$) within the swimming teams, rifle team, or men's gymnastics team in either contrast of any cycle or any interactions between cycles. Significant differences were found in the women's gymnastics team for the emotional-intellectual interaction (Figure 1). The positive phase of the emotional cycle (E1) appears to contradict the biorhythm theory. Figure 1 shows that the LSM (9.48) representing E1-I1 was below the LSM (9.89) of E2-I1 which is not expected. The same situation occurs across I3 where the LSM (8.33) for E2-I3 exceeds that of LSM (8.12) of E1-I3. The LSM differences were not further analyzed for significance since they were not in accordance with the defined biorhythm theory. The results from the general program subjects demonstrated significance in several cases. The AOV performed on hand reaction time revealed a significant ($p=.01$) F-ratio of 4.01 in the physical-emotional interaction. Inspection of Figure 2 shows that phases E1 and E3 are in general agreement with the biorhythm theory across P1, P2, and

P3, although LSM (.62) for E3-P2 was equal to the LSM (.62) of E3-P1 which was not expected. The LSM (.57) of E2-P2 is not in agreement with the theory since it represents a lower, and therefore better time than the LSM (.59) of E1-P2. Again, analysis of the LSM differences for significance was not completed since they were not in accordance with the biorhythm theory.

Whole body reaction time and performance time demonstrated significant F-ratios ($p=.01$) within the intellectual cycle. Least Square Means were calculated and observed to rank correctly according to the biorhythm theory (Table 1).

In summary, no statistical differences were found within the swimming teams, rifle team, or men's gymnastics team in either contrast of any cycle or any interactions between cycles. Significant differences were found in the women's gymnastics team for the emotional-intellectual interaction. The general program demonstrated significant differences for hand reaction time in the physical-emotional interaction, and significant differences for both contrasts within the intellectual cycle for both whole body reaction and performance times.

Discussion

The lack of significance demonstrated by the swimming team contradicted the findings of Martin when significance was demonstrated using swimmers ($N=31$) from three different universities across the nation. The rifle team represented a unique opportunity in athletics to make

repeated collections of data without the direct interference of an opponent. Additionally, all data collected came from a standardized format of shooting procedures that remained consistant throughout the study. Although this represented unusually well controlled data from the athletic realm, no influence of biorhythms could be observed and these results therefore represent evidence against the theory.

Some significance was demonstrated within the women's gymnastics team, and the general program, but the evidence was rather weak and inconsistent. The significant interaction between the intellectual-emotional cycles must be viewed with caution. Although an effort was made to use data from the most controlled varsity sports, gymnastics represented a subjective data group. Judges were used to score performances instead of electrical timers (general program and swimming teams) or physical evidence of an objective score (rifle team) and represented an uncontrollable variable.

The general program represented an attempt to collect controlled laboratory data similar to that of Neil and Sink, where significance was demonstrated utilizing reaction times. Consider the results obtained from the significant interaction between the physical and emotional cycles discovered when hand reaction time was analyzed. The apparent significance was the result of a score not consistent with the defined biorhythm theory. This same

situation is demonstrated in the women's gymnastics team and therefore does not lend support to the biorhythm theory as defined.

It was not surprising to see a significant difference in both whole body reaction and performance times since they were part of the same measurement. It was surprising that these difference were found with the intellectual cycle since both Gittelson and Thommen do not give it much attention and consider the cycle playing a non-dominant role. Initially it was puzzling that hand reaction time and whole body reaction times did not produce significance in the same cycles. The writer felt perhaps whole body reaction and performance represented a more novel task demanding more complete concentration whereas the hand reaction time was less intellectually demanding and therefore reflected only the physiological state of the subject.

It should be noted that the vast majority of research concerning biorhythms and human performance has not upheld the theory as a useful tool. Recently Kauth (1976) has demonstrated no relationship between the three cycles and acute myocardial infarction. If the theory is to be ultimately accepted, sound physiological evidence must be established to help explain the causes in fluctuation of performance. Perhaps instead of fitting performance to the biorhythm cycles, future researchers should observe performance cycles and search for the physiological or

psychological causes.

Conclusion

Although a real difference existed within the intellectual cycle for whole body reaction and performance times, this evidence alone is inconclusive and insufficient to support the theory of biorhythms as it relates to human performance in the areas examined. Until supportive evidence is presented, the biorhythm theory will serve no value to either coach, instructor, or behavioral scientist in predicting fluctuations in human performance. Since the validity of biorhythms is somewhat dubious, serious questions may be raised to those who profit in the marketing of this product as a health related item at this time.

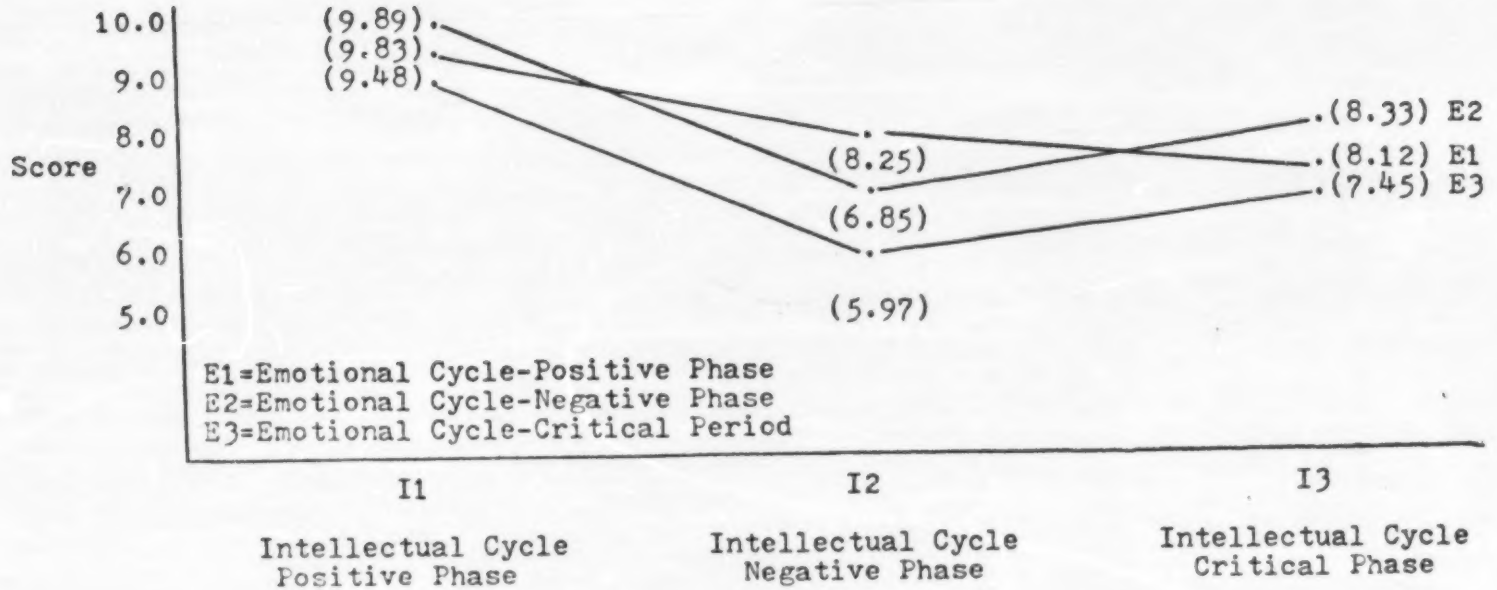

Figure 1

WOMEN'S GYMNASTICS TEAM
INTELLECTUAL-EMOTIONAL INTERACTION

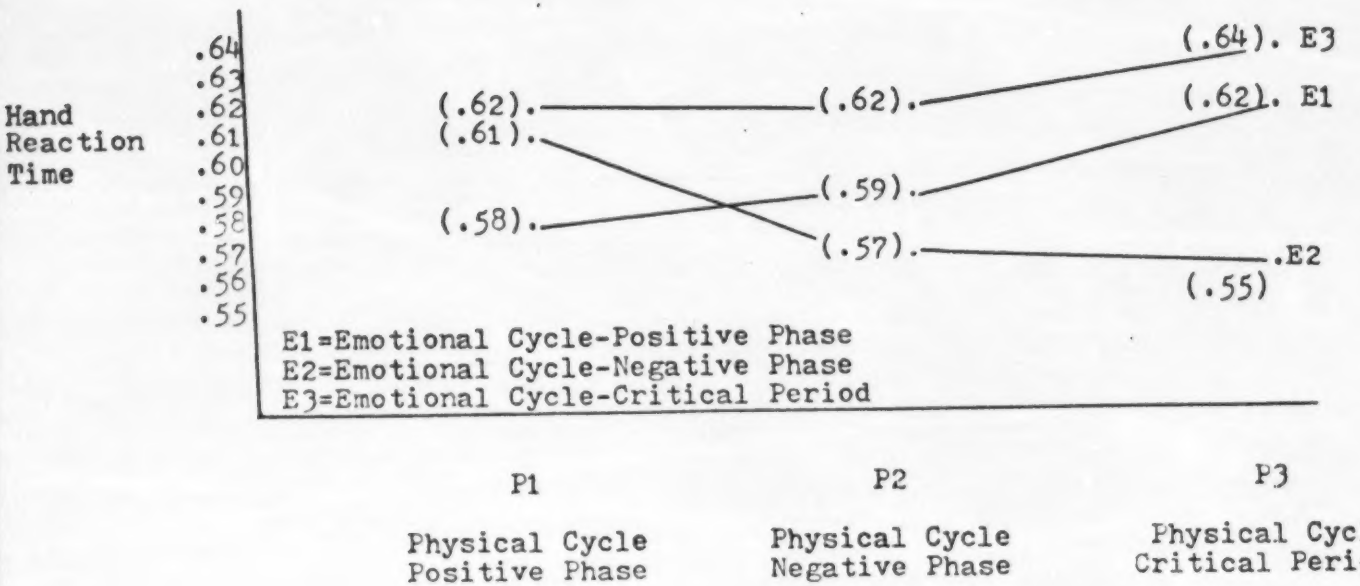

Figure 2

GENERAL PROGRAM HAND REACTION TIME,
PHYSICAL-EMOTIONAL INTERACTION

Table 1
GENERAL PROGRAM AOV CONTAINING DEGREES OF
FREEDOM, SUM OF SQUARES, F-RATIOS, AND PROBABILITY OF A GREATER F (P>F)

Source	Degrees of Freedom	Sum of Square	F-Ratio	P>F
WHOLE BODY REACTION TIME				
Physical	2	0.0025	0.47	0.63
Intellectual	2	0.0289	5.53*	0.04
Emotional	2	0.0040	0.76	0.47
Physical * Intellectual	4	0.0197	1.88	0.11
Physical * Emotional	4	0.0074	0.70	0.59
Intellectual * Emotional	4	0.0191	1.82	0.13
WHOLE BODY PERFORMANCE TIME				
Physical	2	0.0086	0.71	0.49
Intellectual	2	0.2469	4.87*	0.01
Emotional	2	0.0045	0.88	0.41
Physical * Intellectual	4	0.0102	1.00	0.41
Physical * Emotional	4	0.0052	0.51	0.73
Intellectual * Emotional	4	0.0225	2.22	0.07

*Indicates significant F-ratio (9.05)

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Abstract

The purpose of the investigation was to determine if a relationship existed between biorhythms and human performance. The subjects were volunteers from varsity athletic teams and physical education general program classes. Data from varsity athletes were collected from official results of varsity participation and from laboratory testing with the general program subjects. The laboratory testings utilized were choice hand reaction time and whole body movement and performance time. Biorhythms were calculated with the aid of a computer and compared to the performance scores of each subject. The data was analyzed using Analysis of Variance for Unequal Sub-class Numbers. Each cycle was analyzed for differences between the positive versus negative phase and critical versus non-critical periods. Analysis for interaction was completed between the three cycles. Some significant F-ratios were found for the intellectual-emotional and physical-emotional interactions, however, were not in accordance with the theory. Significant F-ratios were also found within the intellectual cycle and were compatible with the theory. It was concluded that the difference found in the intellectual cycle represented inconclusive and insufficient evidence to support the theory of biorhythms in the perameters tested.